

DarkSide Collaboration



APC Paris, France

Augustana College, USA

Black Hills State University, USA

Fermilab, USA

IHEP, China

INFN Laboratori Nazionali del Gran Sasso, Italy

INFN and Università degli Studi Genova, Italy

INFN and Università degli Studi Milano, Italy

INFN and Università degli Studi Napoli, Italy

INFN and Università degli Studi Perugia, Italy

INFN and Università degli Studi Roma 3, Italy

IPHC Strasbourg, France

Jagiellonian University, Poland

Joint Institute for Nuclear Research, Russia

Princeton University, USA

RRC Kurchatov Institute, Russia

SLAC National Laboratory, USA

St. Petersburg Nuclear Physics Institute, Russia

Temple University, USA

University of Arkansas, USA

University of California at Los Angeles, USA

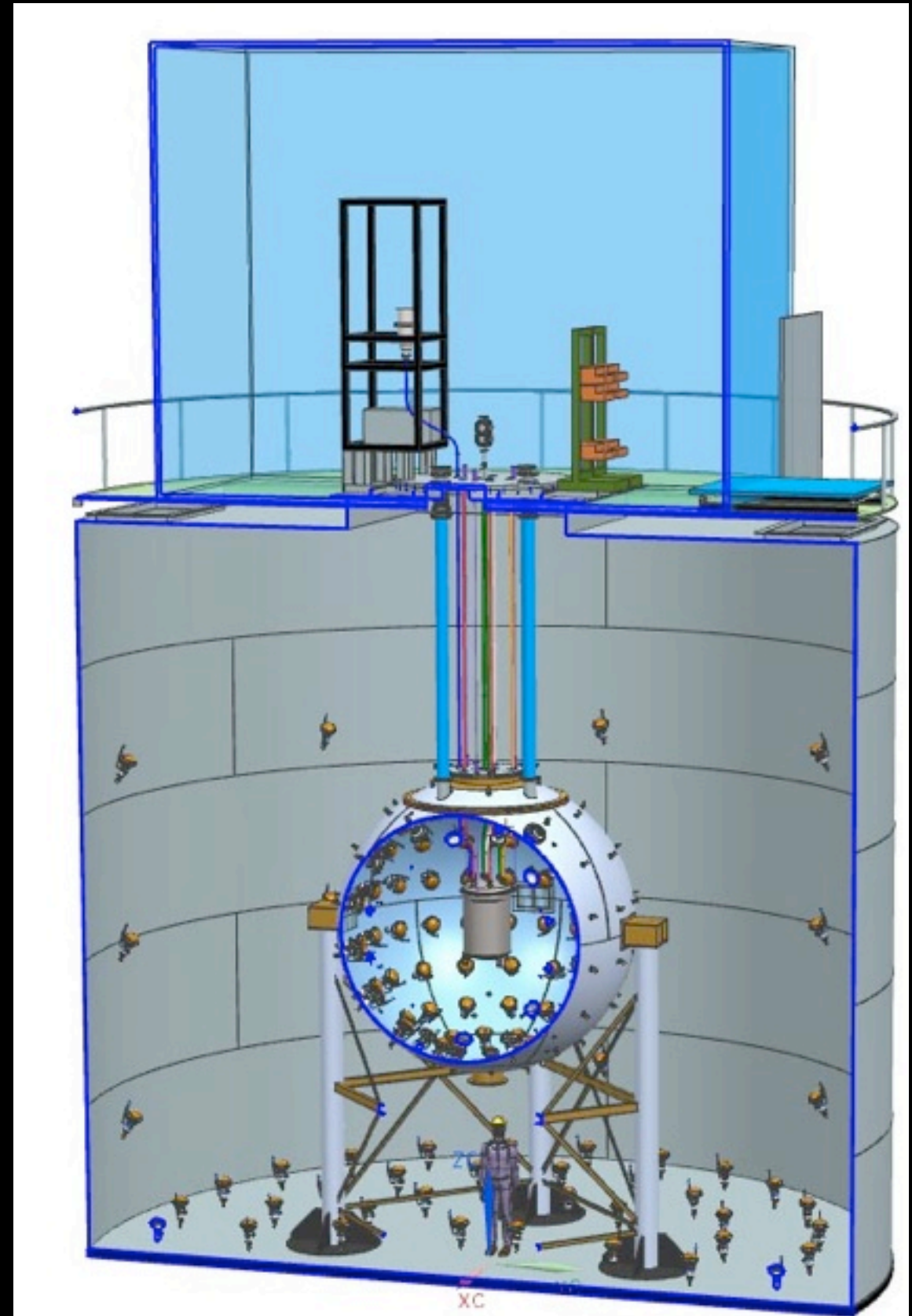
University of Chicago, USA

University of Hawaii, USA

University of Houston, USA

University of Massachusetts at Amherst, USA

Virginia Tech





DarkSide Program:

- Technology for DM detector: 2-phase TPC with underground argon as target - operate at LNGS
- DarkSide-50 ($2 \times 10^{-45} \text{ cm}^2$)
 - Funded by DOE, INFN, NSF
- DarkSide-G2 (10^{-47} cm^2)
 - R&D funded by NSF (NSF DCL, May 1 2012)
 - R&D funded by DOE (G2 FOA, Jan 2013)



Aim at zero-background technology

- Pulse Shape Discrimination (PSD) of Primary Scintillation, S1, (rejects e/gamma) (unique to Argon - atomic physics of Argon dimer)
- Ionization:Scintillation Ratio, S2/S1 (rejects e/gamma - not unique to Argon)
- Sub-cm Spatial Resolution (identify surface bkg) (advantage of two-phase) (feature of 2 – phase TPC)
- Underground argon (avoid event pile-up and background from ^{39}Ar)
- Neutron Veto (identify neutrons with high efficiency in finite volume)
- Water shield (identify muons and avoid cosmogenic neutrons)
- Screen and select all detector materials for minimum radioactivity
- Construct in Radon-free clean rooms



Fermilab Participation in DS-50:

- Underground Argon Purification (PPD *with Princeton*)
- Argon handling system (PPD *with Princeton & UCLA*)
- TPC Data Acquisition System (SCD *with LNGS*)
- Trigger (PPD)
- PMT Bases (PPD)
- Data Storage & Analysis system (SCD & CCD)
- Project management & DOE funds co-ordination



Recent Milestones

- Completed operation of DarkSide-10 - 1 year ($LY > 7$ p.e./keV)
- Constructed as part of DarkSide-50:
 - * 1,000 tonne water Cerenkov muon veto
 - * 30 tonne organic liquid scintillator neutron veto
 - * two Rn-free clean rooms for final preparation of detector
 - * argon recirculation, purification, and recovery systems

All facilities sized and built to house DarkSide-G2

- April 2013 DarkSide-50 TPC assembled at LNGS
- **First DarkSide-50 TPC Commissioning Run completed**



First Commissioning Features

- TPC assembled in clean room
- TPC installed inside neutron veto vessel
- Argon cooling, circulation, and purification system operated
- PMTs operated in liquid argon
- TPC Trigger and DAQ were operated
- HV system operated at required field
- Dual phase operation achieved
- Data to determine light yield obtained (quite encouraging)
- Data to determine electron drift-lifetime obtained (ditto)
- Pre-amps on PMT base (in-liquid) tested (ditto)
- Remote levelling exercised

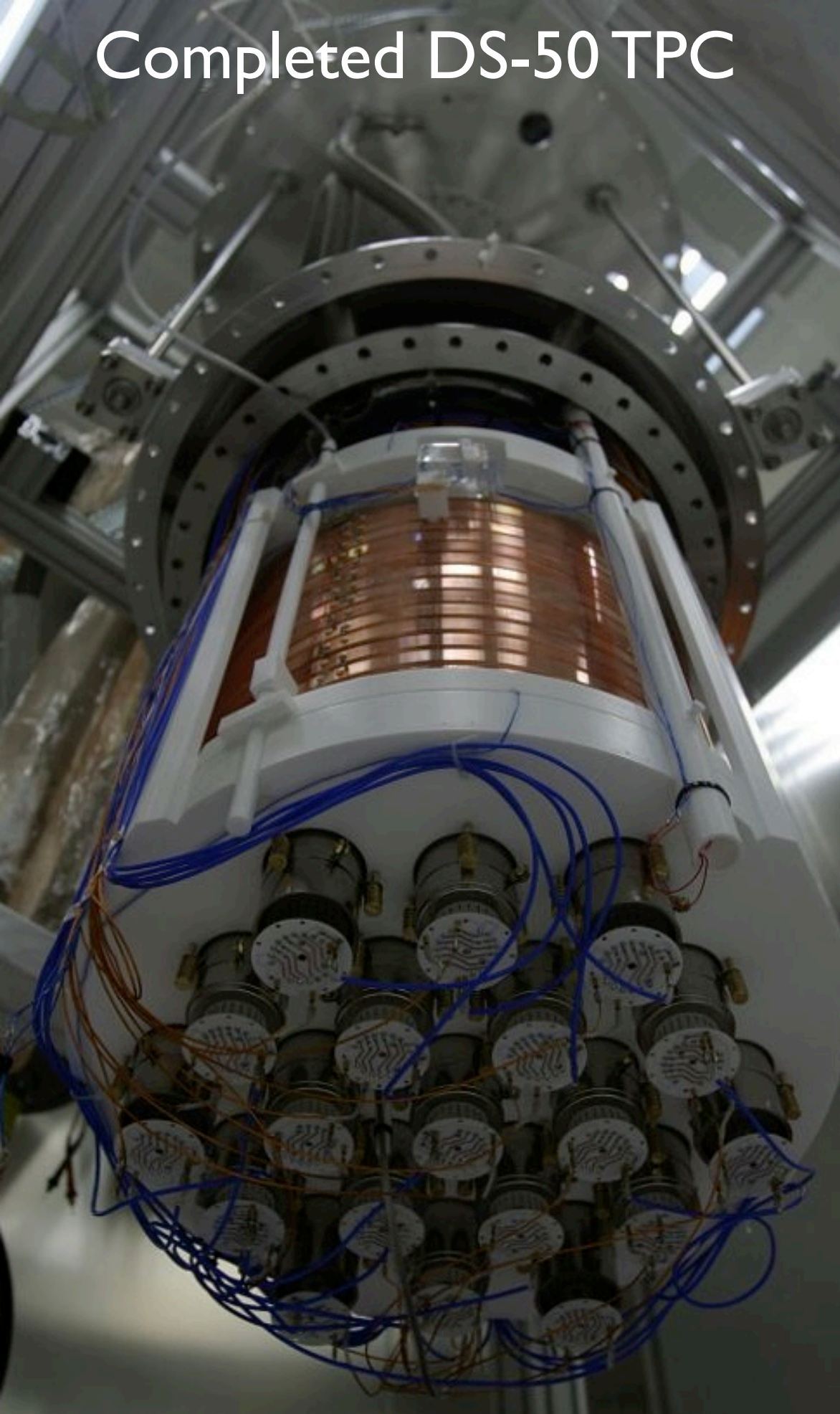
Radon-free Clean Room above Water Tank



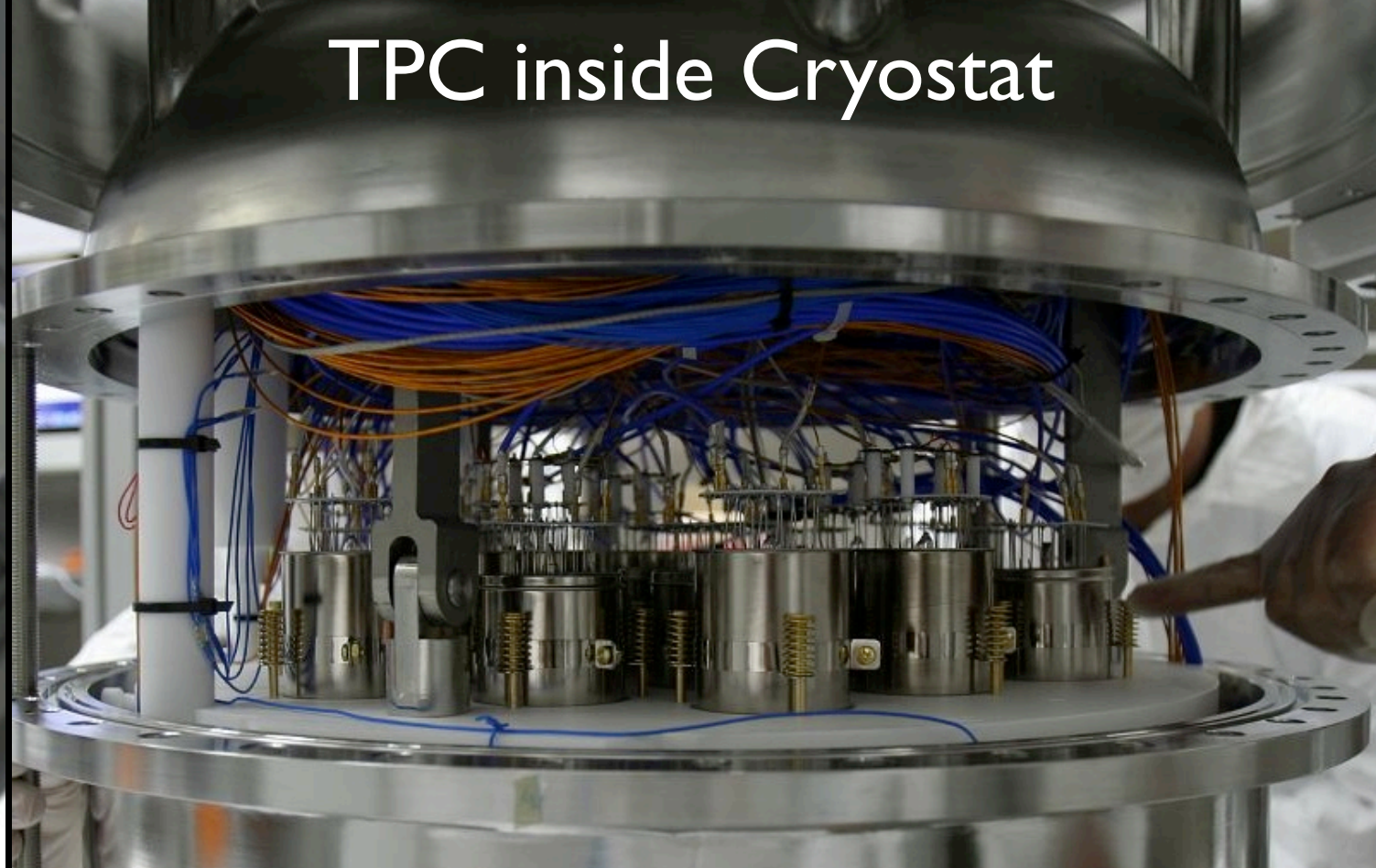
A large, cylindrical liquid scintillator vessel, likely made of stainless steel, is shown from a low-angle perspective. The vessel is supported by a complex network of metal beams and cables. Numerous black cables are bundled and run along the top and sides of the vessel, connecting it to various electronic components. The vessel is situated in a large, industrial-looking space with a white ceiling and other structural elements visible in the background.

Liquid Scintillator Vessel - cabled and tested

Completed DS-50 TPC



TPC inside Cryostat



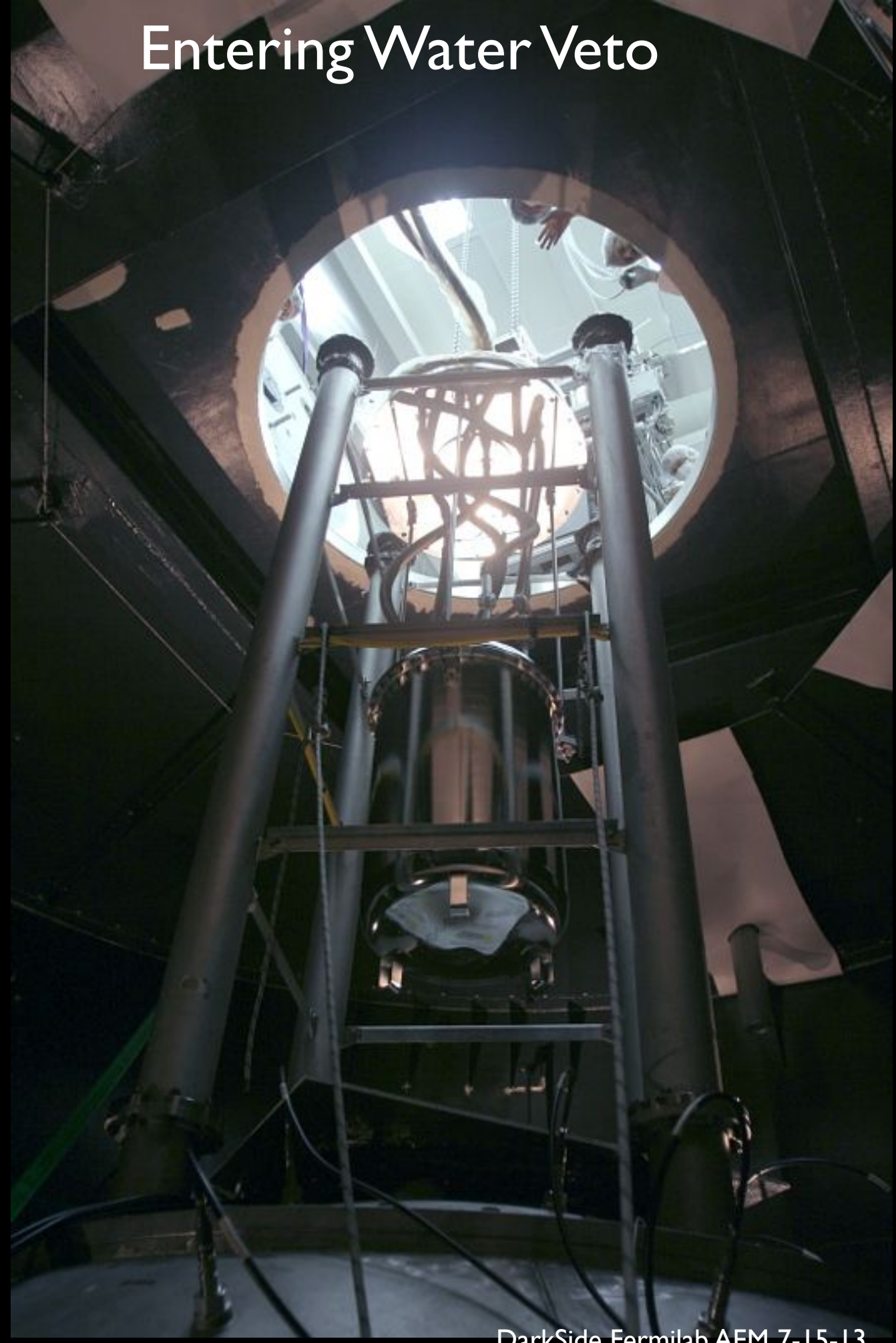
Cryostat and vacuum vessel



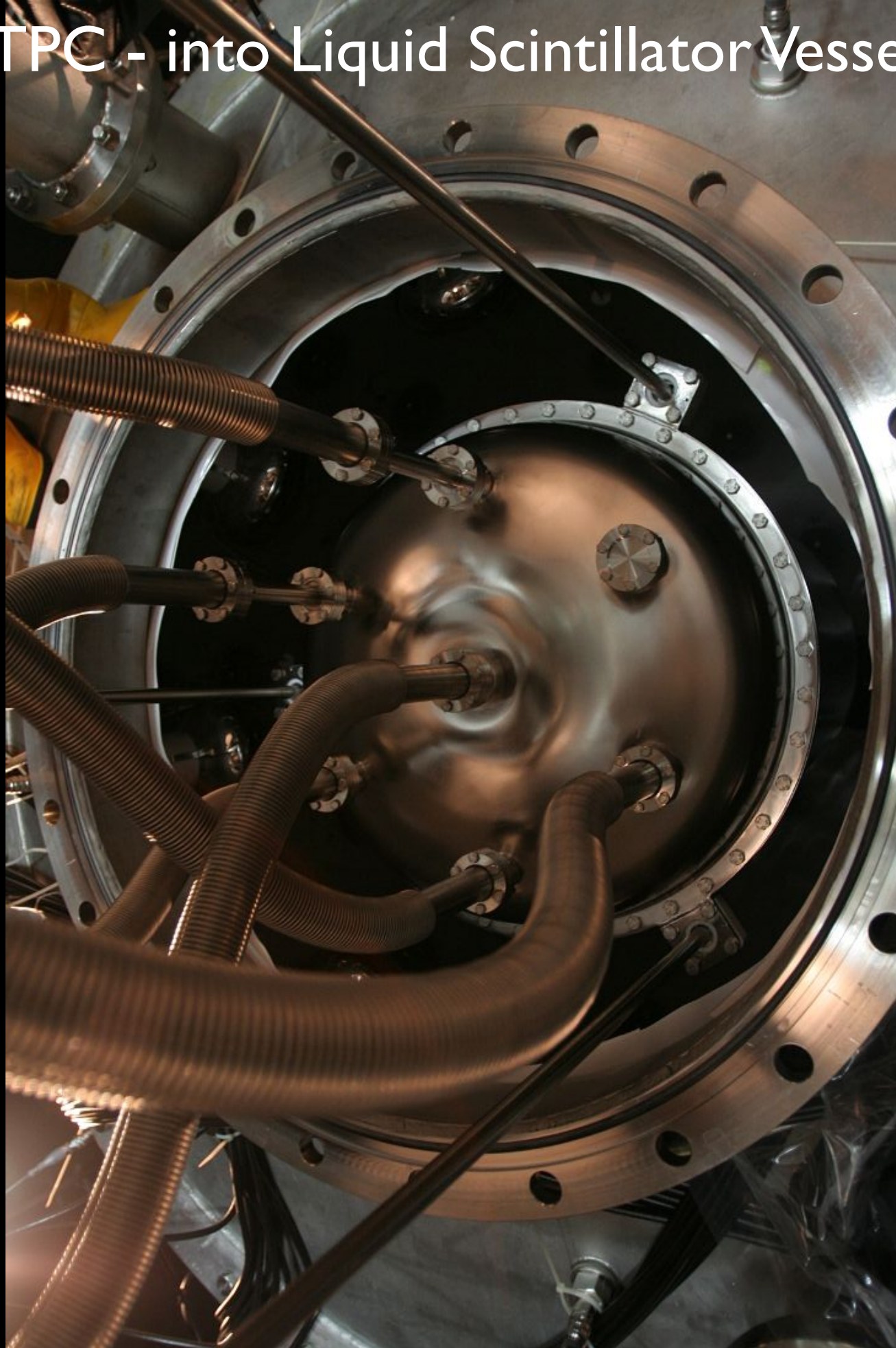
Cryostat with umbilicals on
top flange of LSV



Entering Water Veto



TPC - into Liquid Scintillator Vessel Hanging in Liquid Scintillator Vessel



Water Tank & Liquid Scintillator Vessel with TPC umbilicals



Changes for TPC run to start early August

- Replace bad PMTs
- Instrument all PMT bases with in-liquid pre-amps
- Install super-low radioactivity silica windows
- Fix weak points in the HV system
- Fix some heat leaks in the argon transfer lines
- Continuing improvements to the Trigger and DAQ

Next 6 months

- 1st TPC commissioning run ended June
- 2nd TPC run starting in August
- Fill Neutron Veto and Water Tank by end September
=> Data with complete apparatus, concentrating on background rejection performance
- Low radioactivity argon towards end of year